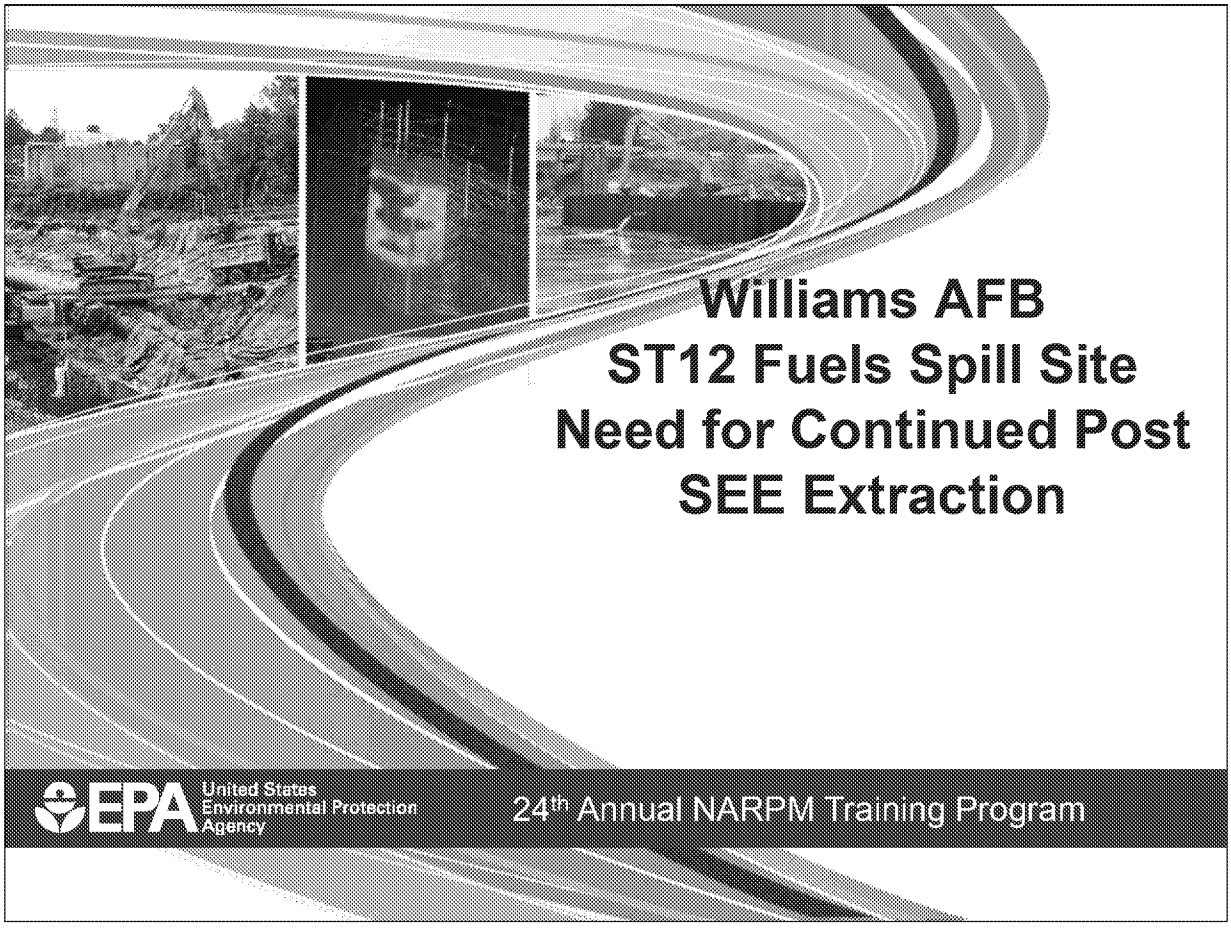
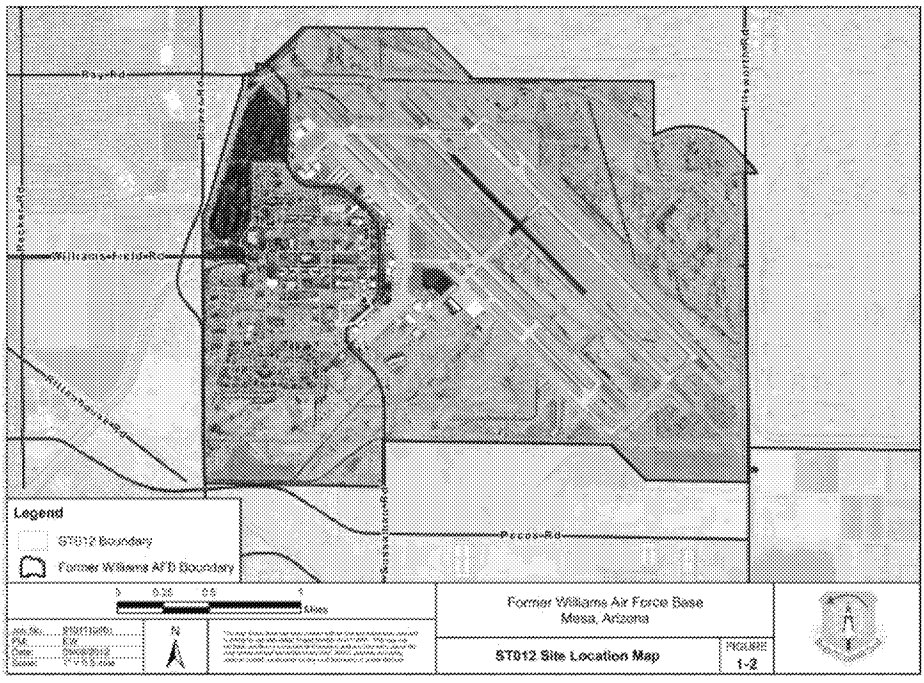

Williams AFB
ST12 Fuels Spill Site
Need for Continued Post
SEE Extraction
EPA United States Environmental Protection Agency
24th Annual NARPM Training Program

0

Williams Air Force Base/ ST12 location

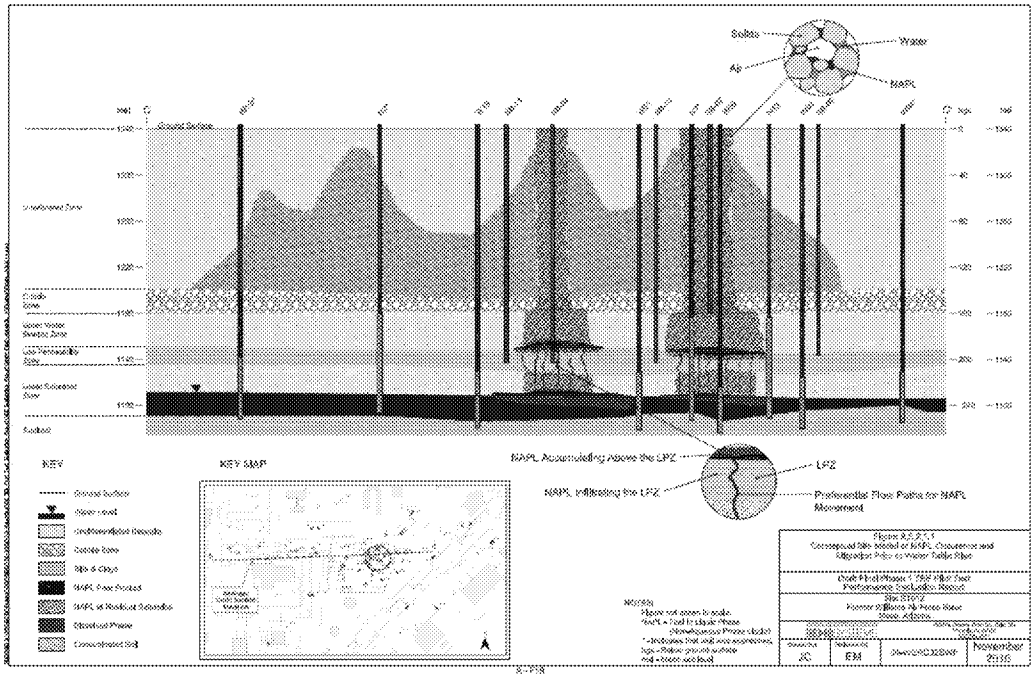


1

Initial Site Characteristics

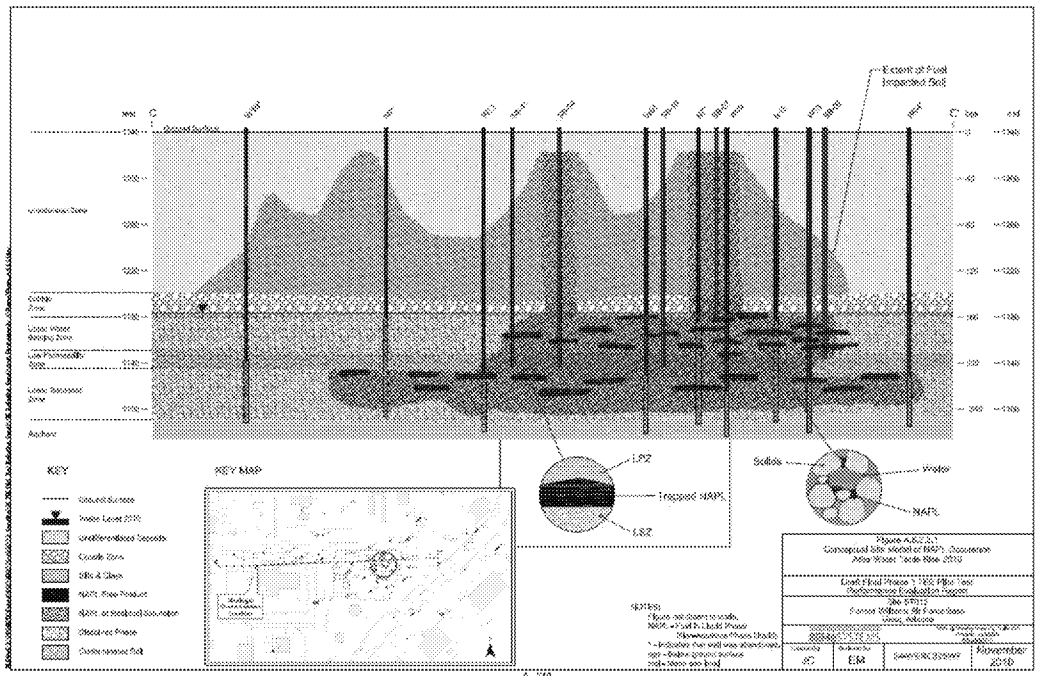
- Fuel LNAPL extent to depth of ~ 240 feet bgs
- Water table has risen to ~ 150 ft bgs, trapping LNAPL below the water table below Low Permeability Zone (LPZ)
- Water table rising 1 - 5 ft/yr – now within high permeability cobble zone
- LNAPL – contaminated area below water table is ~ 450,000 yd^3
- Dissolved phase plume
- 3 hydrogeologic units: Lower Saturated Zone (LSZ); Upper Water Bearing Zone (UWBZ); Cobble Zone (CZ)

Fuel Release Area Conceptual Model



3

Fuel Release Area As Water Table Rises



4

TEE Pilot Completed in 2011

- Pilot test conducted in single cell in center of most contaminated area
- Post steam sampling found LNAPL expansion outside treatment area.

  Possible causes:

  a. Pump failures
  b. Water table rising into more permeable / transmissive cobble zone
  c. Water table rise into vadose zone contamination
- AF continued extraction after pilot test to prevent spread of plume until it could be addressed by full scale SEE

Full Scale Steam Remedy

- Performance based contract to complete SEE remedy awarded to Amec in 2012
- Focused FS and RODA selecting steam signed Sept 2013
- RD Workplan – draft: Oct 2013; Final: June 2014
- Well Abandonment/ Construction/Development: Nov 2013- May 2014
- Piping/Utilities/Boiler installation: April – June 2014
- Begin Groundwater Extraction – September 29, 2014
- Begin Steam Injection –October 14, 2014

System was designed and constructed in advance of final RD/RA workplan approvals; Amec didn't address all agency concerns.

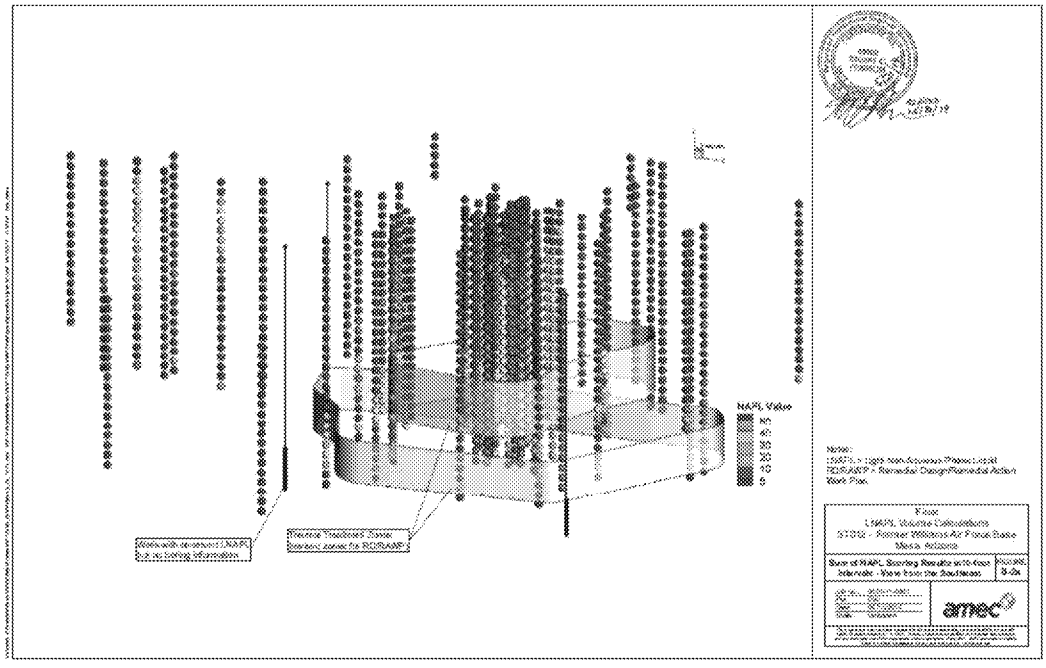
Current Concern

- Steam injection ceased on March 4, 2016 while significant NAPL still being recovered
- SEE extraction sytem was shut down on April 29, 2016

Containment Issues

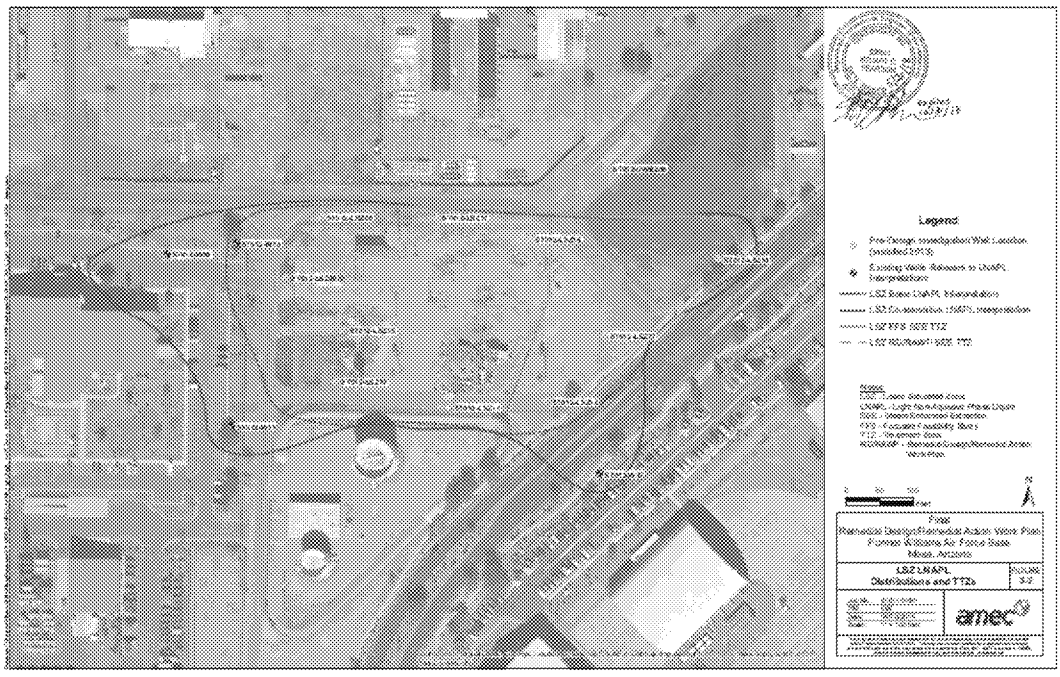
- Hydraulic containment concerns have been raised throughout the SEE Operations; still not addressed through characterization
- Amec is proceeding with EBR proposal without characterizing to confirm remaining mass or spread of plume – how then to evaluate success of EBR?
- Site is still hot and contaminants more mobile
- EBR to use Sodium Sulfate to promote anerobic biodegradation which has lower degradation rate

LNAPL Reconnaissance view from southeast)
LNAPL extends beyond SEE treatment area



Interpretative LNAPL Distribution in LSZ

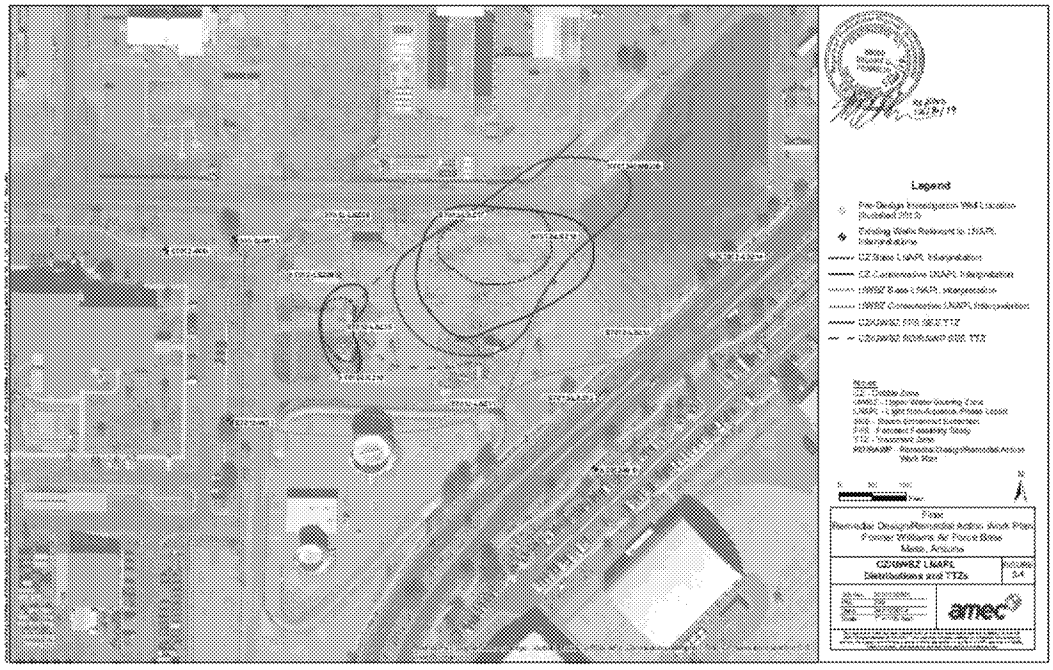
Amec extended SEE treatment area as far as practical in LSZ



Solid Blue - Estimate from feasibility study and original PBR contract budget estimate
Dashed Blue – Expansion of TTZ during Remedial Design; limited by roadway and surrounding building and structures
Dashed Pink - Base case estimated NAPL extent
Solid Pink – Conservative estimate

Interpretative LNAPL Distribution in UBWZ/CZ

Amec chose not to extent SEE treatment boundary, as we requested

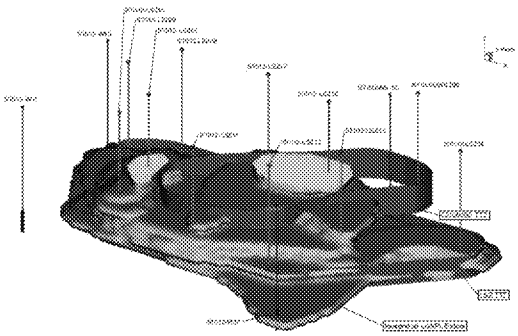


Red – interpretive base case CZ LNAPL extent (dashed) conservative case (solid)
Green interpretive base case UWBZ LNAPL extent (dashed) conservative solid
Blue – UWBZ/CZ TTZ : solid

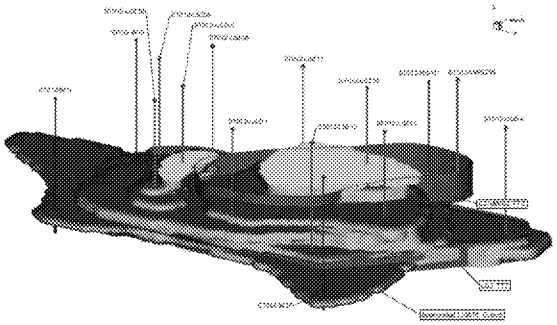
11

Conceptual model of Pre SEE LNAPL distribution (view from southeast)

Base Case



Conservative Case

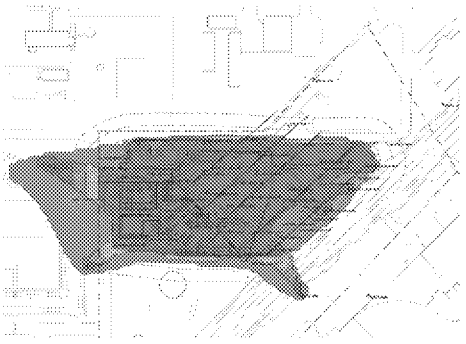


Red band = SEE treatment area

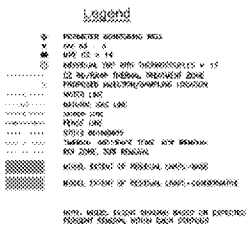
12

Amec's Interpretive Mass Removal – LSZ

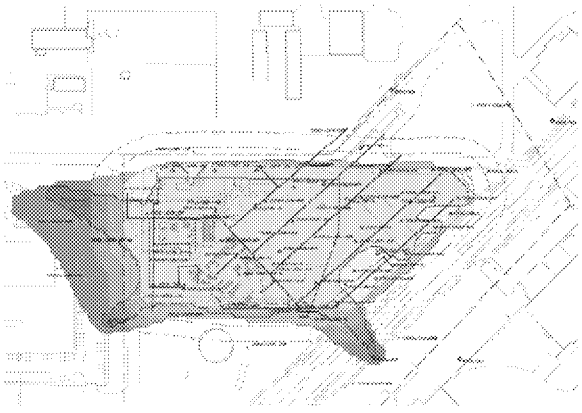
qualitative only, not confirmed



BEFORE SEE

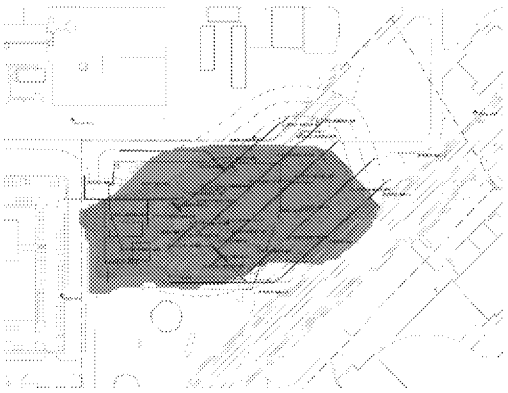


AFTER SEE

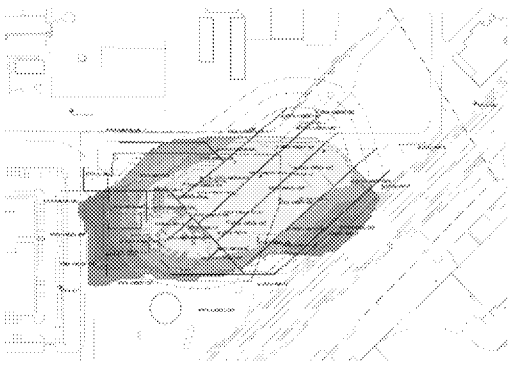


Based upon modeling, have not collected post SEE samples yet

Interpretive Mass Removal - UWBZ

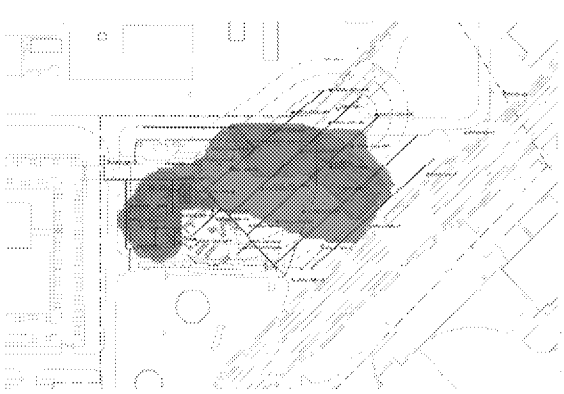


BEFORE



AFTER

Interpretive Mass Removal - CZ



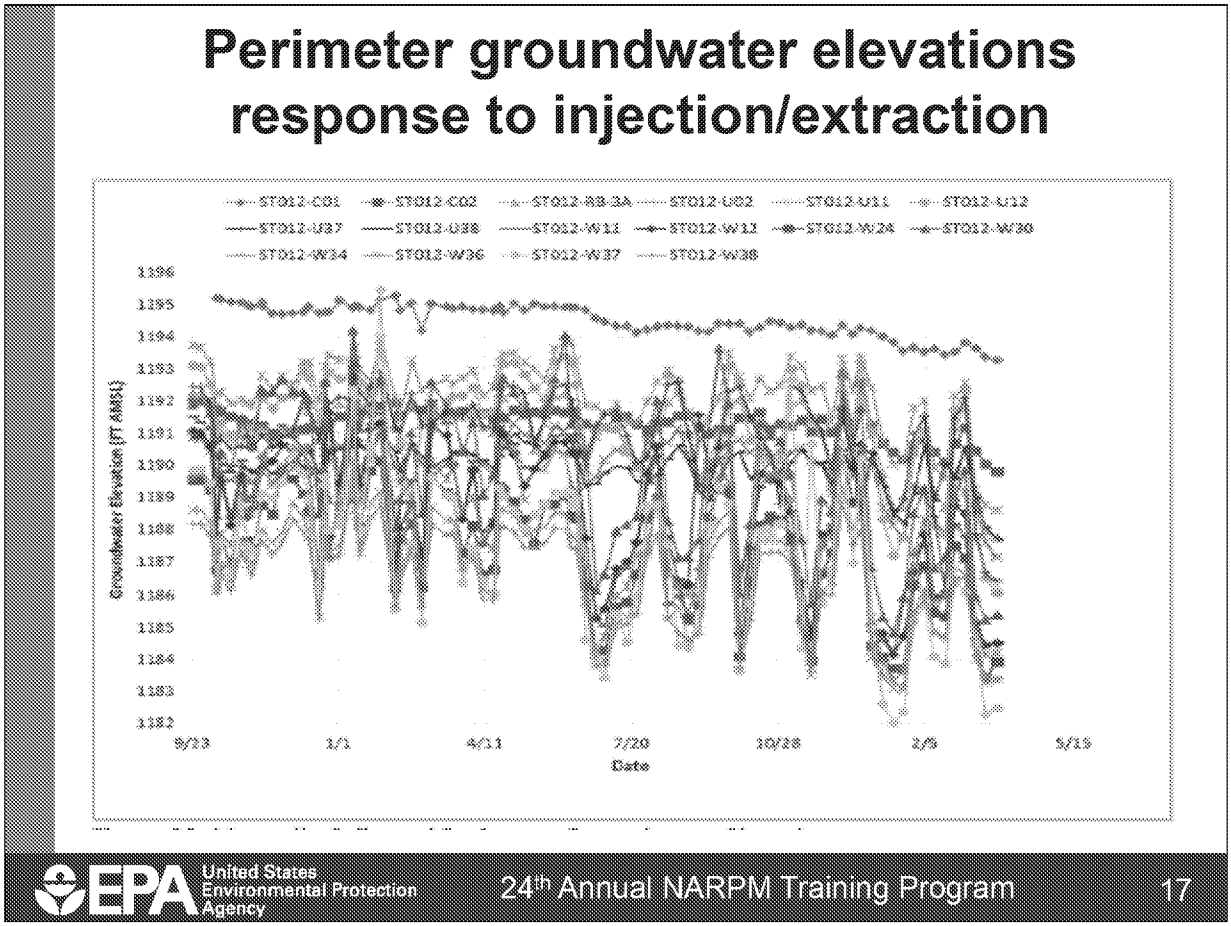
BEFORE

AFTER

Estimate of Remaining LNAPL
from current EBR workplan

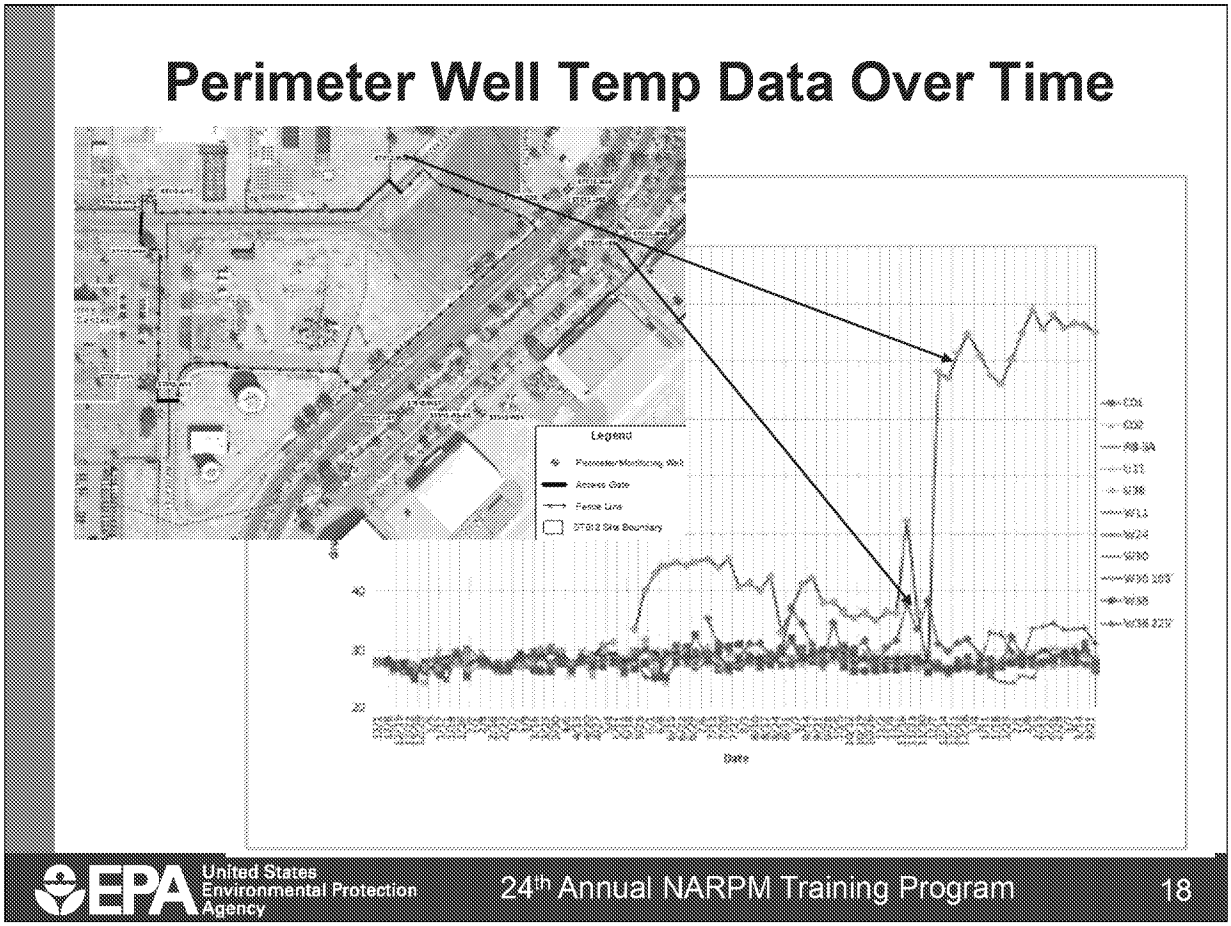
Conservative LNAPL Interpretation

		EBR Treatment Area Volume		Treatment Area Volume		Total Residual Volume	
	TTZ	Calculated Volume of	Volume of LNAPL	Calculated Volume of	Volume of LNAPL	Volume of LNAPL	Volume of LNAPL
Cobble Zone	cu ft	848	607	2,007	1,436	2,655	2,043
	gallons	6,343	4,538	15,014	10,743	21,357	15,282
	NAPL Removed (gallons)	0	0	0	0	0	0
	Remaining NAPL (gallons)	6,343	4,538	15,014	10,743	21,357	15,282
	Uncertainty Factor	50%	50%	75%	75%	75%	75%
	Lower Range (gallons)	3,171	2,269	11,261	8,057	16,018	11,461
Upper Water Bearing Zone	cu ft	23,459	24,625	31,887	33,167	55,057	57,792
	gallons	175,475	184,192	238,148	248,083	411,609	432,261
	NAPL Removed (gallons)	0	0	10,887	10,061	10,061	10,061
	Remaining NAPL (gallons)	175,475	184,192	236,261	238,022	401,767	422,214
	Uncertainty Factor	50%	50%	75%	75%	75%	75%
	Lower Range (gallons)	87,738	92,096	168,711	178,516	301,317	316,660
Low Permeability Zone	cu ft	7,417	7,337	15,661	15,490	23,078	22,827
	gallons	55,481	54,877	117,144	115,868	172,625	170,746
	NAPL Removed (gallons)	0	0	0	0	0	0
	Remaining NAPL (gallons)	55,481	54,877	117,144	115,868	172,625	170,746
	Uncertainty Factor	50%	50%	75%	75%	75%	75%
	Lower Range (gallons)	27,741	27,439	87,858	86,901	129,469	128,059
Lower Saturated Zone	cu ft	13,788	36,654	40,766	97,703	53,693	128,377
	gallons	95,662	229,295	304,926	730,966	400,577	960,261
	NAPL Removed (gallons)	0	0	24,620	24,620	24,620	24,620
	Remaining NAPL (gallons)	95,662	229,295	280,306	706,346	375,957	935,641
	Uncertainty Factor	50%	50%	75%	75%	75%	75%
	Lower Range (gallons)	47,826	114,648	210,229	529,760	281,968	701,731



Containment of contaminants has been a major concern throughout SEE operations

17



High temp water is migrating downgradient – may spread hydrocarbon plume

Extra slides

Full Scale SEE Operation

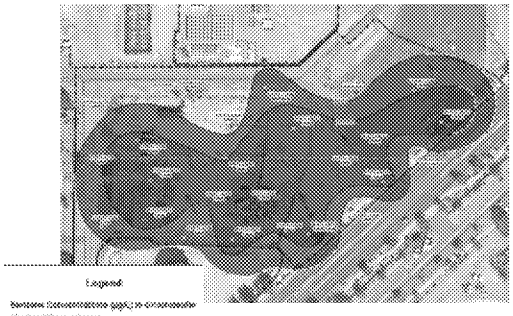
- 34 Injection/Extraction Wells 80 -100 feet apart:
  Injection: 6-cobble zone 10-UWBZ 18-LS
  Extraction: 14-cobble zone 14- UWBZ 27-LSZ
  Dual Purpose: UWBZ- 2
- Groundwater Extraction began on September 29, 2014
- Steam Injection Began October 14, 2014
- Originally anticipated to run approximately 422 days through November 2015.
- Enhanced Bioremediation to Follow Steam Shutdown.

Operational Status as of 3/30/16

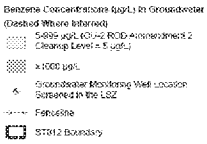
- Total Vapor and Liquid Mass Removal: **2,513,587 lbs** hydrocarbons
- Total Removed as NAPL: **1,374,207** lbs / **209,164** gals reusable fuel
- Average Daily NAPL Mass Removal Last Week **1,538** lbs/day
- Days of Operation: **546** days (129 % of estimate)
- Total Steam Injection **320** million lbs (94% of estimate)
- Total Energy Used **5,666,173** kWh (50% of estimate)
- Total Water Extracted **89,258,784** gallons
- Total Treated Water Discharge **118,237,000** gallons

Benzene in LSZ Groundwater After SEE

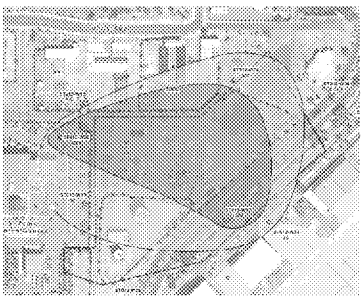
Annual Groundwater Monitoring Report (Nov 2014)



LSZ Pre-SEE

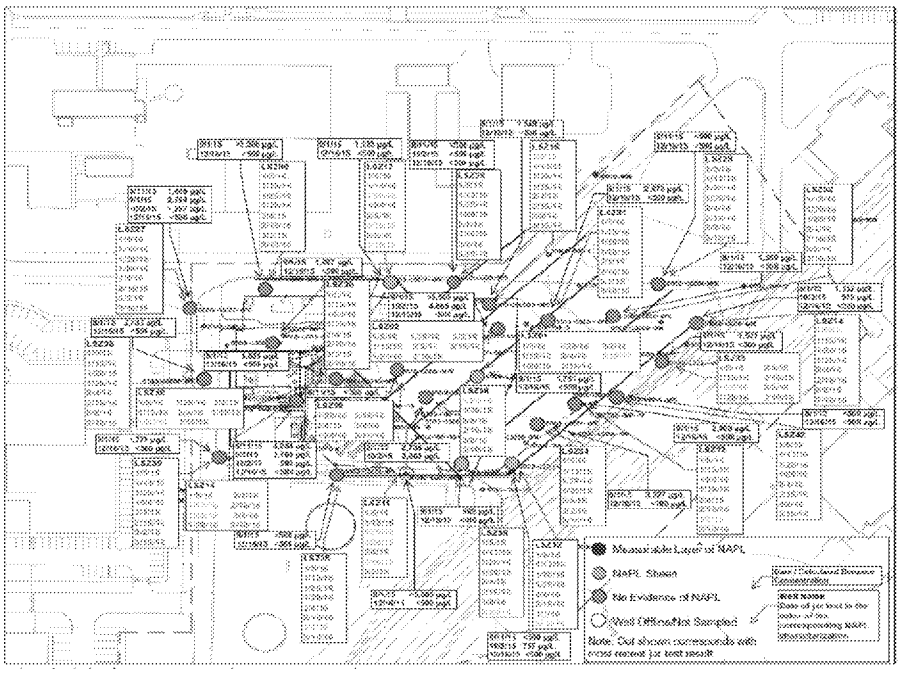


LSZ Nov 2014 Sampling Event



Annual groundwater monitoring reports coming in a year behind (report dated Jan 2016) These samples collected just a few month after steam initiated ; groundwater concentrations have dropped from above 10,000 ug/l to > 1000 ug/l as concentrations are being volatilized or pushed into recoverable NAPL phase

NAPL Jar Test Screening/Calculated Benzene LSZ (November 2015 –March 2016)



Results as of 3/14/16

2 weeks after last pressurization cycle completed on 3/4/16

Jar samples collected from biweekly from wells beginning in November 2015 to look for evidence of NAPL, latest results shown. Green = no evidence of NAPL Yellow = NAPL Sheen Red= measurable layer of NAPL present LSZ had the most NAPL initially, also received the most steam treatment , larger area longer time, also greater pressure with depth. Results shown as of March 14 Weekly Progress Report, After last pressurization cycle ending on March 4

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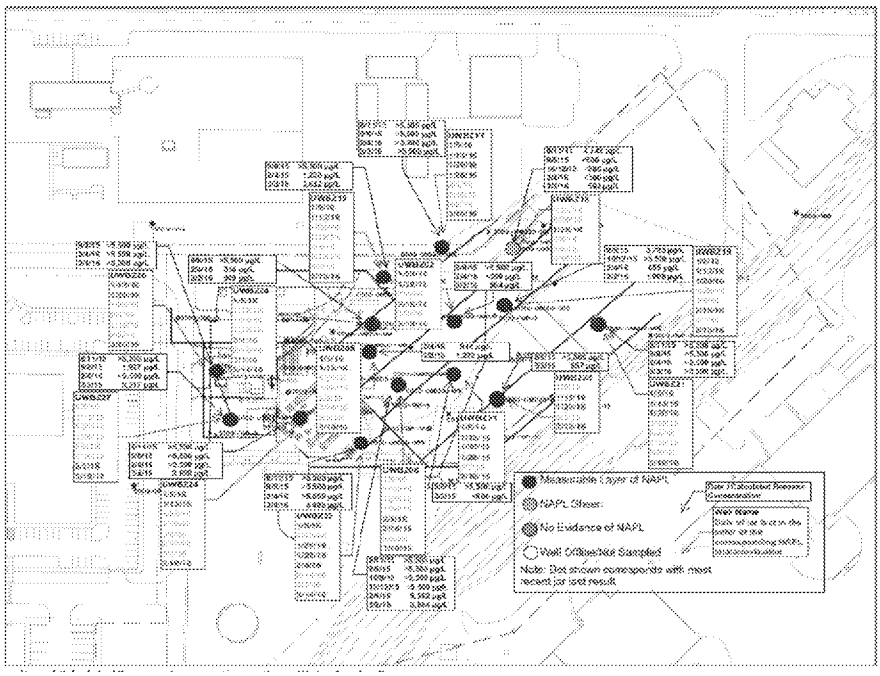
NAPL Jar Test Screening/Calculated Benzene
UWBZ (November 2015 –March 2016)



Results as of 3/14/16

2 weeks after last pressurization cycle completed on 3/4/16

After last depressurization ending March 4, NAPL measured in almost all the UWBZ wells

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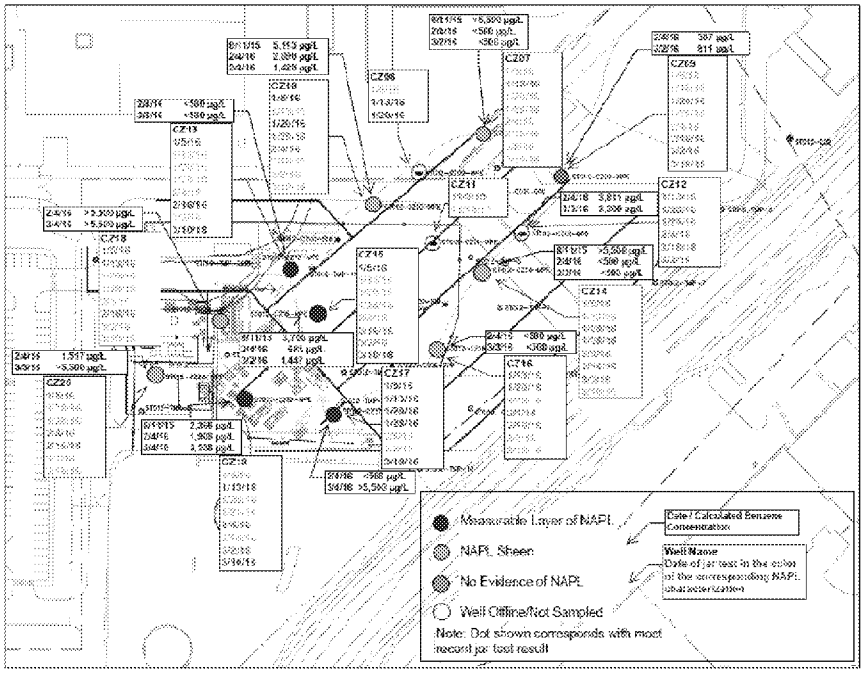
NAPL Jar Test Screening/Calculated Benzene CZ (November 2015 –March 2016)

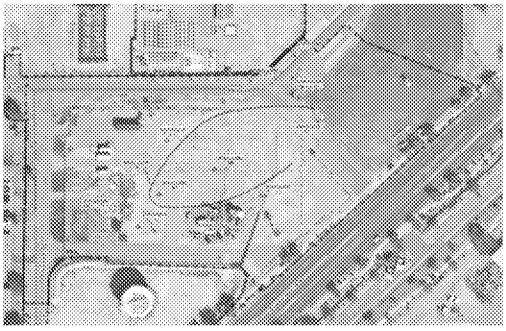


Results as of 3/14/16

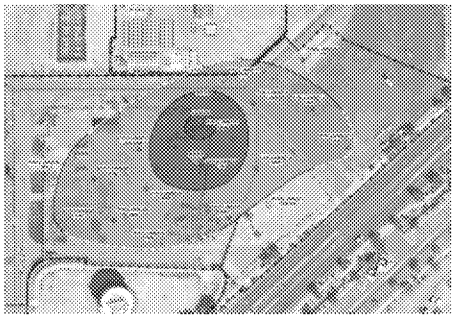
2 weeks after last pressurization cycle completed on 3/4/16

Benzene in Groundwater Pre-SEE (2014)

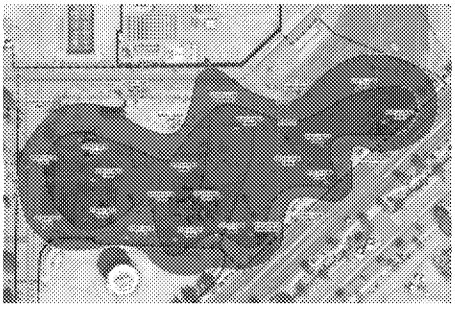
Cobble Zone (CZ)

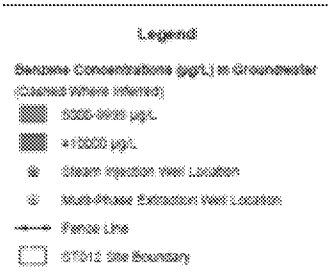


Upper Water Bearing Zone (UWBZ)

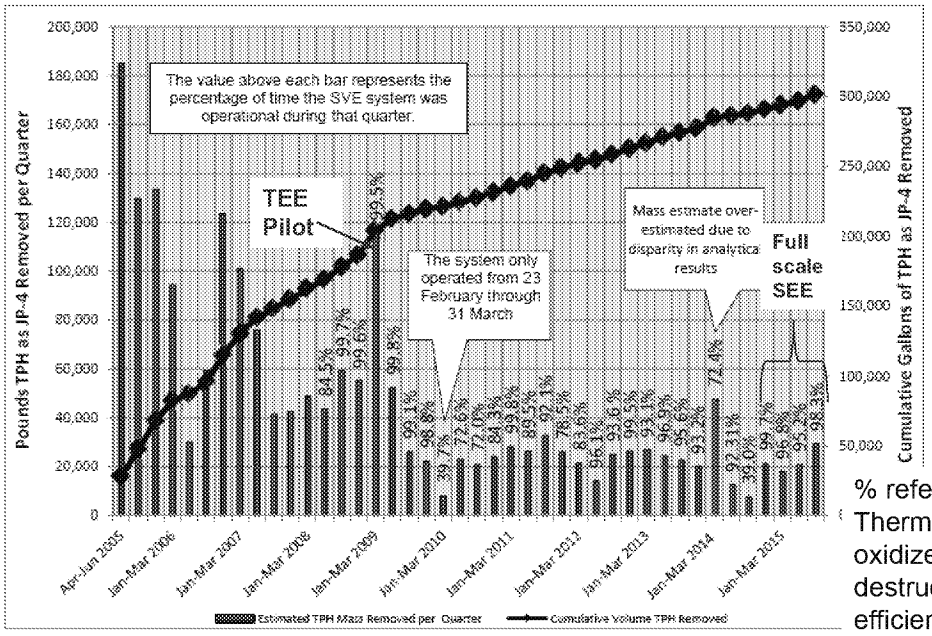


Lower Saturated Zone (LSZ)





SVE Historical Mass Removal TPH as JP4



% refers to Thermal oxidizer destruction efficiency

Most mass removed from SVE in early years, and declining, with a significant increase during operation of the TEE pilot, after that significant drop off in mass recovery. We are not seeing any increase in SVE recovery rate during operation of full scale SEE, which may indicate most of the recoverable mass has been removed

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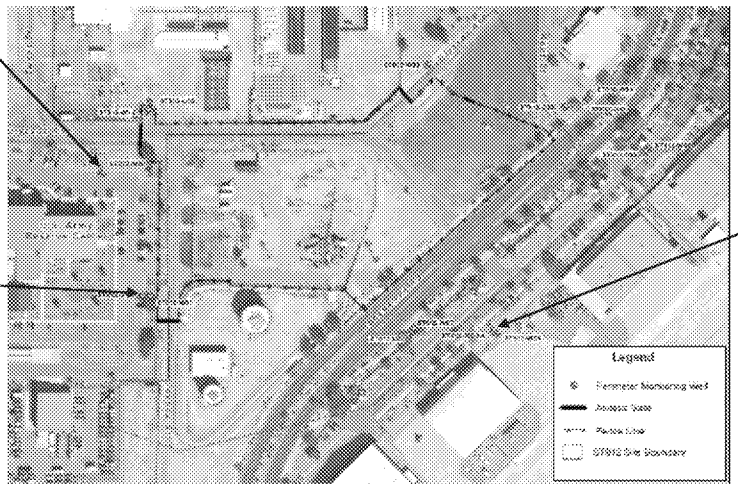
Passive LNAPL Removal in Exterior Wells W11, W30 and W37



About 4000 gallons LNAPL passively removed from 3 perimeter wells

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